SEIZURES PATTERN AND ITS NEURO IMAGING FINDINGS IN CHILDREN

Dissertation submitted to

The Tamilnadu Dr. M.G.R. Medical University

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BRANCH VII – PAEDIATRIC MEDICINE

K.A.P. Viswanathan Government Medical College

Tiruchirappalli

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Chennai

March – 2012

CERTIFICATE

This is to certify that the dissertation entitled **"SEIZURES PATTERN AND ITS NEURO IMAGING FINDINGS IN CHILDREN"** is the bonafide original work of **Dr. P. SELVARAJ** to the Faculty of pediatrics, The Tamilnadu Dr. M.G.R. Medical university, Chennai in partial fulfillment of the requirement for the award of M.D. Degree (Pediatrics) is a bonafide research work carried out by him under our direct supervision and guidance.

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ABBREVIATIONS

2D	-	Two dimensional
3D	-	Three dimensional
3D CISS	-	Three dimensional Constructive interference in Steady State
ADC	-	Apparent diffusion Co-efficient
ADEM	-	Acute Demyelinating Encephalo myelitis
ALARA	-	As low as reasonably achievable
BFS	-	Benign Focal Seizure
Cho	-	Choline
CNS	-	Central Nervous System
CPS	-	Complex Partial Seizure
CSF	-	Cerebro Spinal Fluid
CT	-	Computed Tomography
DWI	-	Diffusion Weighted Imaging
EEG	-	Electro encephalo graphy
fMRI	-	Functional Magnetic resonance imaging
GTCS	-	Generalized Tonic – clonic Seizure
HIV	-	Human Immunodeficiency virus
ICH	-	Intra cranial hemorrhage
JME	-	Juvenile myoclonic Epilepsy
LGS	-	Lennox-Gastaut Syndrome
LRS	-	Localization related seizure
MEG	-	Magneto encephalo graphy
MFS	-	Multifocal seizure
MRA	-	Magnetic resonance Angiography

MRS	-	Magnetic resonance Spectroscopy
MSI	-	Magnetic Source Imaging
MTS	-	Mesial temporal Sclerosis
MERRF	-	Myoclonic epilepsy and Red ragged fibers
MELAS	-	Mitochondrial Encephalopathy with lactic acidosis And stroke like episodes
NAA	-	N-Acetyl aspartate
NCC	-	Neurocysticercosis
NCD	-	Neurocutaneous Disorders
NF	-	Neurofibromatosis
PMFL	-	Progressive Multifocal encephalopathy
PNET	-	Primitive Neuro ectodermal tumors
PSGS	-	Partial seizure with Generalized Seizure
PWI	-	Perfusion weighted imaging
REL	-	Ring Enhancing Lesions
SLE	-	Systemic lupus Erythematosus
SPECT	-	Single-photon Emisson Computer Tomography
SPS	-	Simple Partial Seizure
SSECTL	-	Single Small Enhancing CT Lesions
SWS	-	Sturge – Weber Syndrome
TS	-	Tuberous Sclerosis
TB	-	Tuberculosis
USG	-	Ultra Sonography
XLALD	-	X-Linked Adrenoleukodystrophy

CONTENTS

INTRODUCTION

INTRODUCTION

PEDIATRIC EPILEPSY

Epilepsy is defined by the occurrence of recurrent spontaneous seizures arising from aberrant activity within the brain. Such electrical activity is the net product of biochemical processes at the cellular level occurring in the context of large neuronal networks, and it likely involves cortical and several key subcortical structures.

INTERNATIONAL CLASSIFICATIONS OF SEIZURE TYPE [(1)]

1. FOCAL AND MULTIFOCAL SEIZURES

Simple partial seizures

With motor signs

With somatosensory or special sensory hallucinations

With autonomic symptoms

With psychic symptoms

Complex partial seizures

Simple partial followed by impairment of consciousness

With impaired consciousness at onset

Partial seizures evolving to secondary generalized seizures

Simple partial seizures evolving to generalized

Complex partial seizures evolving to generalized

Simple partial seizures evolving to complex partial seizure

2. GENERALIZED SEIZURES

Tonic – clonic seizures

Absence seizures

Atypical absence seizures

Clonic seizures

Tonic seizures

Atonic seizures

3. MYOCLOMUS, MYOCLONIC SEIZURES, AND INFANTILE SPASMS

4. UNCLASSIFIABLE EPILEPTIC SEIZURES INCIDENCE [(2)]

The overall incidence of childhood epilepsy from birth to 16 yrs – 40 cases in 100,000 children.Incidence is

Upto1yr - 120 in 100,000

1 - 10 yrs- 40 - 50 in 100,000

10 – 20yrs. 20 in 100,000.

Syndrome dominated by generalized tonic conic or partial seizures account for 75% of childhood epilepsy. Syndromes dominated by absence seizures account for approximately 15%, and the secondary generalized epilepsies account for 10%.

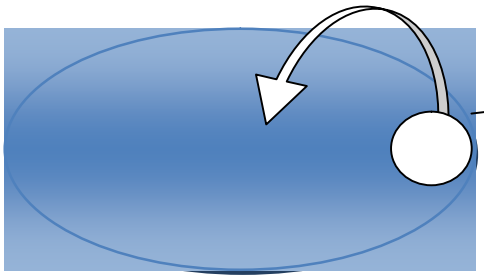
Focal seizures in 43%, with complex partial and partial with secondary generalization most common. For 44%, generalized seizures were dominant, with generalized tonic – clonic seizures most common. Overall, 45% had localization – related epilepsy syndromes, and 48% had generalized syndrome [(3)]

NEUROPHYSIOLOGY OF EPILEPSY

At the cellular level, the two hallmark features of epileptiform activity are neuronal hyperexcitability and neuronal hypersynchrony. Generally, a focal interictal discharge on an EEG cannot be seen unless a minimum of 1 to 2 cm^2 of cortex exhibits increased excitability and synchrony [(4)].

Seizure activity as a perturbation in the normal balance between inhibition and excitation in a localized region, in multiple areas or throughout the whole brain[(5)]. This imbalance is likely a combination of increased excitation and decreased inhibition and, perhaps somewhat paradoxically, in some instances increased inhibition impinging on individual cells.

GENETICS OF EPILEPSY



? Genes relevant to Majority of cases

Rare families: simple inheritance multiple single gene - disorders, Genes encode ion channel sub units.

Majority of cases: Complex inheritance many genes, currently unknown, Modified by environmental factors.

GENERAISED SEIZURES

Seizures are classified into two basic groups: Partial and Generalized. Partial seizures arise from a localized region of the brain. Focal discharges can spread locally through synaptic and non-synaptic mechanisms, distally to subcortical structures, and through commissural pathways to eventually involve the entire seizures secondarily generalize. It is called partial with secondary generalization. Generalized seizures begin with abnormal electrical discharges in both hemisphere and critically involve reciprocal thalamorcortical connections. The electroencephalographic signature of a primary generalized seizure is bilaterally synchronous spike-wave discharges seen across all scalp electrodes. It's called primary generalized seizures.

Primary generalized seizures accounted for 40.5%. Of the primary generalized seizures, generalized tonic clonic are the most common, followed by absence and myoclonic seizures [(6)].

GENERALIZED TONIC-CLONIC SEIZURES

The child may have a headache, insomnia, irritability, or a change in appetite. This prodrome starts hours-days before GTCS occurs. Prodrome is not associated with any EEG epileptiform activity.

GTCS have to distinct phases: tonic and clonic [(7)]. Loss of consciousness usually occurs simultaneously with the onset of a generalized stiffening of flexor or extensor muscle the tonic phase.

During the tonic phase, prolonged extension of the back, neck, and all limbs often occurs. The eyes remain open, and a cry or yell is common. The tonic phase typically lasts 10 to 30 seconds and is followed by the clonic phase. The clonic phase usually starts with a rapid tremor and then slows to massive jerks of the extremities and trunk. The clonic phase typically lasts 30 to 60 seconds.

Cyanosis is common and results from the arrest of ventilation during the tonic phase and insufficient short breaths during the following clonic phase. Pupillary dilation, salivation, sweating, hyperthermia, and incontinence are common.

The seizures evoked by photic stimulation usually are primary generalized in type. Photosensitive epilepsy can be classified into two major groups: (1) pure photosensitive epilepsy, in which clinical seizures occurs only when the patient is exposed to the photic stimulus, and (2) photosensitive epilepsy, in which spontaneous seizures occur in addition to those induced by light stimulation[(8)].

EEG findings

The tonic phase usually begins as loss of background frequencies, with sudden generalized suppression of the background activity, followed by gradual buildup low voltage fast spikes, starting at 20 to 40 Hz and then decreasing to 10 Hz, lasting up to 10 seconds, with a progressive increase in amplitude and decrease in frequency the so called “epileptic recruiting

rhythm." This is followed by the clonic phase, with slow waves following the spikes.

Initial Evaluation

Children with an unremarkable history other than for the seizures and with normal findings on neurologic examination typically require only an EEG and neuroimaging. Neuroimaging, Non – Emergency settings-MRI; Acute situations-CT, mental retardation, developmental regression, or abnormalities on neurologic examination, need for the diagnostic testing such as metabolic screening and CSF examinations.

ABSENCE SEIZURES

Clinical Features

Absence seizures are characterized by an abrupt cessation of activity, change in facial expression, and impairment of consciousness[9,10]. Less than 10% of all seizures [11]. The most common seizure type to go undetected. Common in first 10years of life [12] and it is more common in girls [13].

Typical Absence Seizures

Sudden onset of impaired consciousness, usually associated with a blank facial appearance without other motor or behavioral phenomena, is characteristic. Automatisms, semi purposeful behaviors of which the patient is unaware and subsequently cannot recall.

Four syndromes are Associated With Typical Absence Seizures

- Childhood absence epilepsy
- Juvenile absence epilepsy
- Epilepsy with Myoclonic absences
- Juvenile Myoclonic Epilepsy

Atypical Absence Seizure

- Diminished postural tone, or tonic or myoclonic activity
- Automatisms are less likely
- Longer duration than typical absences
- Atypical absence seizures have lennox- Gastaut syndrome.

Electroencephalographic Findings

- **Typical absence seizure,** the sudden onset of 3-Hz generalized symmetric spike-and-wave or multiple spike-wave complexes maximal in the frontal-central regions.
- **Atypical absences**, the ictal EEG is more heterogeneous, showing 1.5 - 2.5 – Hz slow spike-and-wave or multiple spike-and-wave discharges that may be irregular or asymmetric.

CLONIC SEIZURES

Clinical Features

Clonic seizures are similar to generalized tonic-clonic seizures but are characterized by only rhythmic or semirhythmic contractions of a group of

muscles. These jerks can involve any muscle group, although the arms, neck, and facial muscles are most commonly involved.

TONIC SEIZURES

Clinical Features

Tonic seizures are brief seizures consisting of the sudden onset of increased tone in the extensor muscles [14].

Tonic seizures frequently are seen in patients with lennox-Gastaut syndrome.

EEG Findings

The EEG ictal manifestations of tonic seizures usually consist of bilateral synchronous spikes of 10 to 25 Hz of medium-to-high voltage, with a frontal accentuation.

ATONIC SEIZURES

Clinical Features

Atonic seizures, or “drop attacks,” are characterized by a sudden loss of muscles tone [16]. They begin suddenly and without warning and cause the patient, if standing, to fall quickly to the floor. Children with atonic seizures are more likely to fall backward than children with atonic seizures. Because muscle tone may be completely absent, the children have little means by which to protect themselves, and injuries often occur.

LENNOX-GASTAUT SYNDROME

Lennox-Gastaut syndrome is characterized by a mixed seizure disorder. Of which tonic seizures are a major component [15]. Mental retardation is present before onset of seizures in 20% to 60% of patients.

Electroencephalographic Findings

The slow spike-and-wave or sharp-and-slow-wave complexes consist of generalized discharges occurring at a frequency of 1.5-2.5 Hz.

Etiology

Primary refers to cases in which the etiology is idiopathic, whereas secondary refers to cases in which the disorder is symptomatic of a definable etiology.

Disorders Commonly Associated with Lennox-Gastaut Syndrome

Prenatal	Perinatal	Postnatal
Cerebral dysgenesis	Hypoxia/ischemia	Meningitis/encephalitis
Tuberous Sclerosis	Intracranial hemorrhage	Postinfectious
Congenital infection		Cerebrovascular Disease
Stroke		Hypoxia/ischaemia
		Status epilepticus
		Head injury
		Hypoglycaemia
		Degenerative disorders

FOCAL AND MULTIFOCAL SEIZURES

Focal or partial seizures originate in one region of the brain, where they may stay confined or spread to other areas. Multifocal seizures arise from multiple locations and constitute an important type of seizure in infancy and childhood. It constitutes 60% of all seizure disorder [17]. In a majority of children with focal seizures, no focal structure lesion is present and the seizures either are the expression of an idiopathic disorder (benign roloandic epilepsy)

INTERNATIONAL CLASSIFICATION OF SEIZURE DISORDERS (MODIFIED)

Classification of Focal Seizures

A. Simple partial seizures

Clinical seizure type: Simple partial seizures, consciousness not impair ed.

EEG ictal discharge: Local contra lateral discharge starting over the corresponding area of cortical representation (not always recorded on the scalp; broad, diffuse rhythms possible when the source is deep).

EEG interictal expression: Local contralateral interictal epileptiform discharge, and pleomorphic (or varied) with associated slowing when associated with symptomatic etiologic disorder.

1. With motor signs
    a. Focal motor without march
    b. Focal motor with march (jacksonian)

c. Versive (Adversive)

d. Postural

e. Phonatory (Vocalization or arrest of speech)

With autonomic symptoms (including epigastric sensation, pallor, sweating, flushing, piloerection, and papillary dilation)

2. With somatosensary or special sensory symptoms (simple hallucinations, E.g., tingling, light flashes, buzzing)

    a. Somatosensory (Post Central gyrus)

    b. Visual

    c. Auditory

    d. Olfactory(uncinate fits)

    e. Gustatory

    f. Vertiginous

3. With psychic symptoms (disturbance of higher cerebral function); rarely occur without commonly such as complex partial seizures

    a. Dysphasic

    b. Dysmnesic (e.g., deja vu)

    c. Coginitive (e.g., dreamy states, distortions of time sense)

    d. Affective (i.e., fear, anger, and other emotional states)

    e. Illusions (e.g., macropsia)

    f. Structured hallucinations (e.g., music, scenes)

B. Complex partial seizures

Clinical seizure type: Complex partial seizures, with impairment of consciousness, sometimes beginning with simple symptoms.

EEG ictal discharge: Unilateral or frequently bilateral discharge, diffuse or focal in temporal or frontotemporal regions.

EEG inter ictal expression: Unilateral or bilateral, generally asynchronus focus; usually in the temporal regions.

1. Simple partial onset followed by impairment of consciousness
    a. With simple partial features (described in part A) followed by impaired consciousness
    b. With automatisms
2. With impairment of consciousness at onset
    a. With impairment of Consciousness only
    b. With automatisms
    c. **Partial seizures evolving to generated tonic-clonic seizures**

Clinical seizures type: Generalized tonic-clonic seizures with partial or focal onset

EEG ictal discharge: Discharge like those for complex partial seizures, becoming secondarily and rapidly generalized.

1. Simple partial seizures evolving to generalized tonic-clonic seizures.
2. Complex partial seizures evolving to generalized tonic-clonic seizures.

3. Simple partial seizures evolving to complex partial seizures evolving to generalized tonic-clonic seizures.

d. Partial seizures with uncertain alternation of consciousness (useful for infants and other special populations)

EEG ictal discharge: Behavioral arrest seizures often are accompanied by rhythmic discharge in the temporoparieto-occipital region. Clonic seizures have a contralateral ictal expression, usually consisting of repetitive spikes, spike-and-wave discharges, or highly rhythmic delta. Spasms themselves area associated with electrodecrements, but focal seizures may precede, accompany, or follows the cluster. Tonic postures often are accompanied by diffuse attenuation or lowvoltage fast patterns. Versive seizures in the younger population often have a posterior quadrant correlate

Interictal EEG expression: Pleomorphic interictal epileptiform discharges and focal slowing may be seen. In the immature infant, it is common to observe multifocal spikes, even in the setting of focal structural lesions. Here, focal slowing, attenuation, or both are useful features indicating a focal process.

1. Behavioral arrest
2. Clonus: focal or unilateral
3. With associated spasms (may come before, during, or after the cluster)
4. Tonic
5. Versive

SEIZURE SEMIOLOGY INDICATING A FOCAL SEIZURE

1. Aura
2. Behavioral arrest (in most cases, although patients with absence also have behavioral arrest)
3. Focal clonus
4. Focal dystonic posture
5. Focal limb automatisms
6. Spasms (approximately one fourth of patients with spasms have associated focal seizures)
7. Tonic postures (particularly asymmetric tonic posture, although symmetric tonic postures also seen infants with seizures)
8. Version (involving the head, eyes, or both)

ETIOLOGY

Partial seizures are more likely to be associated with focal hemispheric lesions.

1. Cortical Malformations

Of particular importance for focal seizures are focal and hemispheric malformations including cortical dysplasia (Taylor types I and II), schizencephaly, isolated heterotopias, and hemimegalencephaly. Patients with lissencephaly may have focal seizures, but the widespread nature of the malformation places patients with this disorder in the generalized symptomatic epilepsy syndrome category.

2. Congenital and Perinatal Factors

Chromosomal pathologic conditions may result in malformations. Intrauterine infections, specifically cytomegalic inclusion disease, toxoplasmosis, and rubella, are well known for their ability to cause abnormal brain development, Syphilis, rare in many parts of the world, also may cause intrauterine brain infection, with serve neurologic residua. Maternal exposure to radiation during pregnancy or ingestion by the mother of teratogenic drugs also may lead to cerebral malformations. Tuberous sclerosis may manifest during the first few months of life and may be accompanied by focal seizures or infantile myoclonic spasms.

3. Brain Tumors

Tumors that are relatively less malignant and slow growing are more often associated with seizures than are malignant tumors. Focal seizures accompanied by a history of headaches may be caused by tumor.

4. Postnatal Infectious Diseases

a. Seizures often are the first indication of bacterial meningitis
b. Focal or multifocal seizures may be associated with viral encephalitis.
c. Diphtheria-pertussis tetanus immunization
d. Parasitic infestation, Neurocysticercosis/ Echinococcosis
e. Tuberculosis with tuberculoma formation

5. Trauma

Focal seizure may result from subdural hematomas in childhood; multifocal seizure can result from bilateral sub-dural hematomas.

6. Cerebrovasuclar Disease

SWS usually manifests with a port-wine nevus in the distribution of one or more divisions of cranial nerve V. The associated angiomatosis is found over the ipsilateral cortex in the pia-arachnoid. The associated gyri are atrophied, and linear calcifications may be present, most often in the occipital lobes.

Congenital heart disease or bacterial endocarditis may cause emboli that flow to the brain and precipitate seizures.

Considerations in the differential diagnosis of early onset hemiplegia include fibromuscular hyperplasia, intraoral trauma to the internal carotid artery, carotid artery dissection, and arteritis.

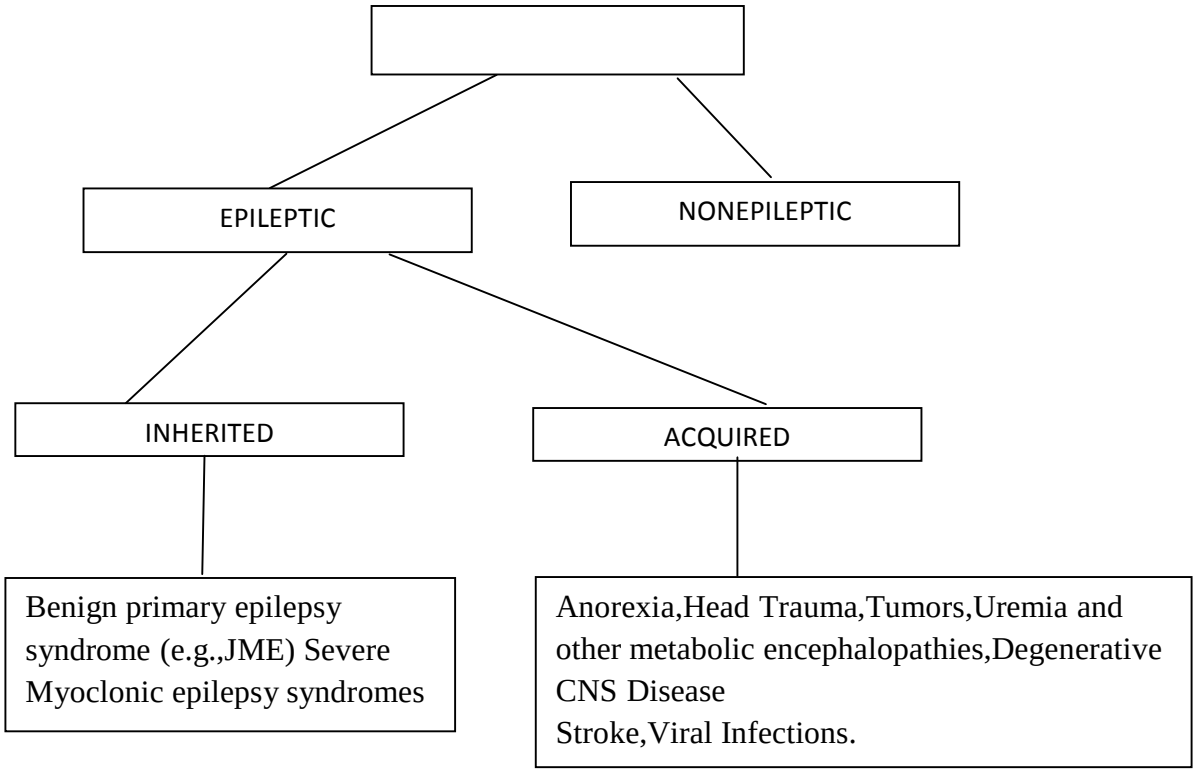
Moyamoya disease and mitochondrial disorders, sickle cell disease, circulating lupus anticoagulant, and homocystinuria may produce similar insults.

MYOCLONUS, MYOCONIC SEIZURES AND INFANTILE SPASMS

Definition

Myoclonous(from the Greek Myo"muscle" and Klonus "agitation/Violent contraction" has been defined as a "sudden ,involuntary shock like muscle contraction arising from the central nervous system"[21].

OVERVIEW OF MYOCLONUS CATEGORIES



Classification of Myoclonic Seizures and Syndromes

Myoclonic Seizures of Infants, Children and Adolescence

Infants

Early infantile epileptic encephalopathy

Benign Myoclonic epilepsy of infancy

Severe Myoclonic epilepsy of infancy

Infantile spasms

Storage disorders

Mitochondrial disorders

Other progressive entities

Children and Adolescents

Familial Myoclonic epilepsy

Myoclonic seizures in Lennox –Gastaut syndrome

Absence with Myoclonic features

Juvenile Myoclonic Epilepsy

Mitochondrial disorders

Progressive Myoclonic epilepsies

Degenerative /Storage disorders

Syndromes of Infants: Infantile Spasms (West's Syndrome)

Infantile spasms occurs primarily during the first year of life especially between the third and eight months, regardless of the timings of any instigating factors (e.g., intrauterine infection or stroke, tuberous sclerosis, perinatal asphyxia, postnatal insult).Infantile spasms were first brought to attention by Dr.W.J.West in 1841,who documented the disorder in his own son[(22)]. The movements may consists of head and body flexion with leg extension.

EEG Findings: The presence of hypsarrhymia, a disorganized, high voltage pattern with no normal background.

PEDIATRIC NEURO IMAGING

A clear understanding of various types of seizure in children and knowledge of normal neuroanatomy and its alternations in various disease process are prerequisites for the correct performance and interpretation of the

many powerful neuroimaging technique that are available. Different modalities of neuroimaging techniques continue to evolve, with better resolution in 2D sand 3D depiction of anatomy and its aberrations in disease processes in the field of pediatric USG, CT and MRI. Even though these remain the mainstay of Pediatric Neuroimaging, the techniques, interpretation and usefulness of functional neuroimaging have been improved by development of other methods including DWI, MRS, SPECT, PET and fMRI.

CRANIAL ULTRA SOUND

Sonography is portable, fast, and multiplaner, and it can be performed at the bedside. Pulses of non-ionizing ultra sound at a frequency of 3.5 – 10 MHz are applied by a transducer to the area of interest. The ultrasound waves are reflected at different amplitudes from organ and tissue interfaces. A reflected sound waves or Echo is represented as a dot, with the gray shade or brightness of the dot proportional to the strength of returning Echo and the location of the dot related to the depth of the reflecting structure.

- B – Mode Scanning (Brightness Mode)
- Real – Time ,Gray – scale sonography
- Duplex Doppler/Color Doppler Ultrasonography.

USG can screen for developmental malformation and for intrauterine infections and to determine the cause of an enlarging or enlarged head.

Real – time sonography can display echogenic (Bright) structure, such as choroid plexus, hemorrhage, some tumors, and focal areas of cerebritis, and

sonolucent structures, such as CSF in the ventricles, subarachnoid spaces, cysts and cystic lesions.

Lesions containing CSF or CSF – filled like contents are well delineated because of the echo lucency of water. eg., ventriculomegaly, porencephaly, Dandy- Walker syndrome, arachnoid cyst and Encephalocele. Vascular malformations, aneurysm of Vein of Galen, can be well demonstrated with color Doppler USG. Major migrational anomalies, such as agyria – pachygyria and lissencephaly, may be delineated by USG; however smaller heterotopias or other subcortical dysplasias may be overlooked. USG is helpful in the evaluation of a newborn suspected of having TS as it can detect the intra cranial hamartomas or subependymal nodules.

COMPUTED TOMOGRAPHY

CT has been available since the 1970 for clinical use in children. Ionizing radiation due to X - ray CT is effectively restricted to the immediate body part of interest by the tight collimation used to create the thin fan beam used for scanning.

Helical CT	Axial
Multidetector CT	Coronal plane
Multislice CT	Multiplaner

Each CT examination contributes to the lifetime exposure. It is necessary to limit radiation from CT in children and follow the ALARA principle.

The digital demographic image is composed of a matrix of voxels. Each voxel is assigned a numeric value called a CT Number, which is related to the tissue density. Most system express CT number in Hounsfield units, with water used as a references and assigned a value of zero. Fatty tissues with less than water have Negative CT Number; whereas positive CT number indicate a tissue density greater than water. Most soft tissue elements have positive CT Number.Calcium, mineralized bone, and concentrated blood elements higher than most soft tissues. CT is limited by streaking artifacts in areas adjacent to thick bone or metallic objects such as dental fillings and gunshot wound pellets.

Abnormalities can be characterized with CT as having low density, isodensity, or high density in relation to the Brain. Lesions that appear lower in density include edema, necrosis, infarction, neoplasms, leukodystrophies, Inflammations, and cysts. Loss of gray white matter differentiation may be seen with diffuse brain edema after hypoxic ischemic injury on a demyelinating process. Fat containing lesions usually appears less dense than water or of mixed density, as in patients with a teratodermoid type of tumors. Air appears as the lowest density and can be seen in pneumocephalus lesions. Isodense to normal tissue are difficult to recognize unless there are change that demonstrate

displacement or replacement of normal anatomic structure. Intravenous contrast material that helps to separate the lesions from normal structures.

High density lesions seen in hemorrhage or the presence of calcium. Pathologic intra cranial calcifications can be seen with Congenital infections, Neurocysticercosis, Intracranial tumors, TS, SWS, NF, Cockayne's syndrome, hypoparathyroidism, AV malformations, Vein of Galen malformations, Encephalomalacia, Cerebral infraction, or the sequelae of perinatal asphyxia. Hypercellular neoplasms with high nuclear - Cytoplasmic ratios (Medulloblastomas, other primitive neuro ectodermal tumors, germinomas, lymphomas) may also appear as high density lesions on CT.

In neurodegenerative diseases of childhood, CT may reveal decreased attenuation in the basal ganglia and cerebral white mater of focal or generalized cerebral atrophy. CT can be helpful in evaluating NCS to detect calcification as in TS.

Contrast enhanced CT is helpful in the evaluation of suspected or known Vascular malformations, neoplasms, abscesses and Empheymas.

MAGNETIC RESONANCE IMAGING

MRI uses magnetic fields and radiofrequency pulses to obtain high-resolution images of the body. Hydrogen nuclei are used to generate detectable signals in MRI. MR images are created by sending radiofrequency pulses into patients lying in an external magnetic field, thereby perturbing hydrogen nuclei in to producing signals of various intensities from different body tissues. In

MRI the resulting signals are mapped onto a gray-scale digital image. The intensity of the signals produced in MRI are determined by several factors, such as the photon density, the mobility of the photons within the molecular lattice (T_1 relaxation), and the effect of local magnetic field produced by magnetic nuclei within the tissue (T_2 relaxation).

Tissue with short relaxation times, such as Fat and intercellular and extracellular metHb, produce high signal intensity on T_1 weighted images. CSF, muscle, deoxyHb, and Hemosiderin, tissue of substances with long T1 relaxation times, appear dark on T_1 weighted images, Tissues or structures with long T_2 relaxation times, such as CSF, edema, many tumors, Extra cellular metHb, infracts and multiple sclerosis plaques, are bright on T2-weighted images, whereas tissues or substances such as muscle, Cortical bone, deoxyHb, and hemosiderin are dark as a result of short T_2 relaxation tissues.

Pathologies includes migrational anomaties, such as gray-matter heterotopias, closed-lip Schizencephaly, Lissencephaly, Pachygyria and hemimeganencephaly, and NCD, such as NF, that are not seen well on CT are better demonstrated with MRI.

MRI is useful in the evaluation of patients with movement disorders such as Wilsons ds, it demonstrates abnormal T_2 signal in the basal ganglia[(27)], and in Huntington's ds revealing atrophy of the caudate nuclei and increased T_2 signal in atrophic caudate nuclei. In panthothenate kinase deficiency (Hallervorden-spatz sydrome), MRI demonstrates areas of symmetric low

signal intensity in the antero lateral aspect of the globus pallidus, so called Eye of tiger sign. MRI shows multi focal cortical infarctions and the presence of lactate peaks in photon MR Spectroscopy in Mitochondrial disorders, such as MELAS. In other Mitochondrial disorders, such as MERRF syndrome, Kearns-Sayre Syndrome, Leigh's syndrome, Alpers'ds, and Menke's ds, symmetric white matter T_2 hyperintensities with involvement of deep cerebral nuclei are observed on MRI.

For focal and diffuse white matter disease, T_2-weighted MRI is more sensitive then CT. MRI should preferentially be used to evaluate children with ADEM, HIV Encephalitis, and Sickle cell disease, Vasculitis such as SLE, lyme ds, PMFL and multiple sclerosis. Recognizable patterns of while matter involvement can be seen with MRI in certain inherited lenkodystrophies. For example, early diffuse involvement of the peripheral subcortical white matter is seen in Pelizaeus – Merzbacher ds, Canavan's ds, and Alexander's ds. In Canavan's ds, on photon MR Spectroscopy, a larger than normal NAA peak is produced. In Alexander's ds, there in predilection for T_2 lengthening in frontal while matter and enhancement after contract. Predilections for occipital while matter involvement is seen with ALD. In globoid cell Lenkodysrophy (Krabbe's) T_2 hyperintensity can be seen in Cerebellum and deep cerebral white matter, whereas the thalami and basal ganglia may be hypointense.

MRI can demonstrate mesial temporal Sclerosis, and can reveal small tumors in the aqueduct, Sella turcica or brainstem even when the CT is normal.

High resolution images of the brain capable of detecting of lesions not identified with standard MRI, including hippocampal dysplasia, hippocampal atrophy, and dual pathology with cortical dysplasia.

MRI is the procedure of choice when children present with symptoms and signs that suggest CNS tumor.

For vascular and Hemorrhagic lesions, MRI is more specific. MRA then added a new dimension to the evaluation of pediatric Cerebrovascualr disease. This imaging technique can be used to evaluate vascular malformations, vaso-occlusive ds, and vascular neoplasms.

MRI may detect silent infarction in children with Kawazaki's ds or Sickle cell ds. MRI can differentiate arterial from venous occlusive disease. In evaluating ICH caused by angiographically occult lesions such as cavernous angiomas, MRI in the procedure of choice. Special MRI sequences are available that can differentiate CSF containing lesions (arachnoid Cysts) from other lesions (Epidermoid tumour).MRI is excellent in delineating midline abnormalities including lesions in the Sella, aqueduct, Foramen magnum, and pineal region,

MAGNETIC RESONANCE SPECTORSCOPY

MR Spectroscopy is clinically useful, non-invasive tool for indentifying the biochemical state of the CNS. Certain atomic nuclei such as H (Photons) are magnetic, and when exposed to a strong magnetic field, they align in a particular orientation until equilibrium is reached. If the nuclei are then excited

by a radiofrequency pulse at their resonant frequency, they produce a detectable signal during relaxation back to equilibrium. During relaxation, because of their local chemical environment, each photon produces a signal at a slightly different frequency, called a chemical shift. After a Fourier transform analysis, the plots of the resulting nuclear spectra appear as peaks of signal intensity versus signal frequency on chemical shift.

Small concentrations of metabolites, such as Creatine, Cho, NAA, lactate and many amino acids can be detected using acquisition sequences.

Spectral Metabolites Using Proton Magnetic Resonance Spectroscopy

Proton MR Spectroscopy in being used to investigate a wide range of Neurologic disorders. Metabolites measured with H-MR Spectroscopy include NAA, a neural marker, Creatine composed of phosphocreatine and its precursor creatine which are bio energetic metabolites; .Cho- Containing compounds including free cho and phosphoryl and glycerophosphoryl cho that are released during membrane disruption; lactate, which accumulates in response to tissue damage or anaerobic glycolysis; and glutamate and immediately formed glutamine and myoinositol an osmolyte and astrocyte marker.

Diseases Studied with Photon Magnetic Resonance Spectroscopy

Protons MR Spectroscopy combined with MRI is useful in screening children for metabolic and mitochondrial disorders based on the detection of increased cerebral lactate level or the presence of other elevated metabolic

peaks[23]. Abnormalities have been reported in pts with glutaric aciduria type 2; pyruvate dehydrogenase deficiency, Leigh's syndrome; XL ALD. In phenylketonuria, elevated phenylalanine level. In canavan's ds, an elevated NAA peaks and have abnormally increased NAA/ creatine and NAA/Cho ratios. Leigh's ds, MRS reveals an abnormally high lactate peak and & decreased NAA peak in Basal ganglia.

Localized proton MRS have indicated decreased NAA, increased Cho, and increased lactate levels in epileptic foci compared with nonictal or contralatetal regions.

Malignant pediatric brain tumors are characterized by an increase in cho/ NAA ratio and a decrease in NAA/ creatine ratio.A general decrease in the NAA and creatine peaks and an increase in Cho. Cho signal intensities are highest in astrocytomas and anaplastic astrocytomas, and creatine signal intensities were lowest in glioblastomas. Proton MR Spectroscopy may be useful in differentiating various types of cerebellar tumors, such as primitive neuroectodermal tumors, low grade astrocytomas, and ependymomas.

DIFFUSION- WEIGHTED IMAGING

DWI is technique that uses MRI to measure the diffusion of water through tissues. Random displacement of water molecules (i.e. diffusion) are modified by structural and physiologic factors in the medium. In a medium in which diffusion of water molecules is identical in all directions the process called ISOTROPIC diffusion. When the process depends on direction, it is

called ANISOTROPIC diffusion. DWI has been used to investigate stroke and hypoxic-ischemic injury in children, to differentiate solid from cystic CNS lesions and to evaluate patients with demyelinating disease.

DWI is useful in differentiating cystic brain tumors (high ADC) from epidermoid tumors(lower ADC).

In XL ALD, significant abnormalities with diffusion tensor imaging that are not seen on conventional MRI. In case of B12 deficient lenkoencephalopathy, reduced anisotropy occurred within white matter lesions with T2 abnormalities. DWI can detect larger areas of involvement than conventional MRI in demyelination process. In patients with sickle cell disease and in acute CNS event like,acute CO poisoning, dural sinus thrombosis, acute infarct DWI is an essential part of the investigations.

Children with new onset prolonged seizure can develop unilateral hippocarnpal sclerosis. The presense of diffusion restriction in the affected hippocampal region can herald subsequent development of MTS[(26)].

DWI may show diffusion restriction in solid portions of PNET, a finding unusual in non PNET[(25)]. Hyper intensities can be seen in lymphomas on DWI.

DWI is useful in evaluating children with intra cranial infection cerebral abscesses, uberculomas, subdural empyemas, epidural abscesses demonstrate hyperintensity with DWI. Naeurocysticercosis and encephalitis appear hyperintense whereas toxoplasmosis lesions produce variable signal intensity.

DWI is helpful for the early diagnosis of stroke, reveals hyper intensity in an acute infarct soon after the onset of ischemia.

PERFUSION MAGNETIC RESONANCE IMAGING

PWI is an extension of MR technology that allows evaluation of blood volume, blood transit time and blood flow as relative measures. Two technique have been developed

1. **Dynamic Contrast - Enhanced Susceptibility-Weighted Perfusion Imaging**

   It can be used to image relative differences in blood volume over time.

2. **The Blood Oxygen Level – Dependent Technique**

   It can be used to quantify cerebral blood flow:

   - ❖ It can demonstrate regions of Acute ischemia before lesions are detectable by MRI.
   - ❖ In patient with Sickle cell disease, abnormalities on PWI are associated with neurologic symptoms although the areas of abnormalities may not be seen in conventional MRI, MRA or transcranial Doppler study.
   - ❖ PWI has also been used to differentiate tumor types.
   - ❖ PWI also helpful in children with ADEM, Cerebral AV malformations and other proliferative angiopathies.

SUSCEPTIBILITY-WEIGHTED IMAGING

A sequence using a high-spatial-resolution, 3D, Fast, low-angle MRI technique that is extremely sensitive to Susceptibility.

- SWI has been very useful in detecting hemorrhagic lesions associated with DAI. This technique can also be used to categorize tissue as normal appearing or with non-hemorrhagic or hemorrhagic injury.
- This blood – Sensitive Sequence has been found to be extremely valuable in detection of hemorrhage in children with accidental or non-accidental trauma, infarctions, tumors, Proliferative angiopathies and Vascular malformations, including SWS, Cavernous angioma and in patients with hypertensive encephalopathy.

FUNCTIONAL MRI

fMRI is a technique that measures changes in tissue perfusion based on changes in blood oxygenation. It is used to study regional brain activity in response to sensory, motor and Cognitive stimulation.

fMRI in being used in patients with various neurologic diseases, including medically refractory epilepsy and brain tumors.

MAGNETIC SOURCE IMAGING

MSI uses **magnetoencephalography**(MEG). When Source localizations modeled from the magentoencephalographic signal are registered with high resolution, and it displays functional information in an anatomic context.

MEG is powerful and accurate tool for the pre – surgical evaluation of children with refractory epilepsy, and pre-operative localization of epileptiform activity.

MEG helpful in evaluating patients with dyslexia. MEG provides additional information regarding the spatial relation between brain lesions and functional cortex.

SOLITARY SINGLE RING ENHANCING LESION OF BRAIN[48]

A. Neoplasms

1. Primary Neoplasm
    a) High Grade Glioma
    b) Meningioma
    c) Lymphoma
    d) Leukemia
    e) Pituitary macroadenoma
    f) Acoustic neuroma
    g) Craniopharyingioma.
2. Metastatic carcinoma and sarcoma

B. Infection /Inflammation

1. Bacterial fungal parasitic

2. Empyema of epidural / subdural / intraventricular spaces.

C. Hemorrhagic-Ischemic Lesion

1. Resolving Infarction

2. Aging hematoma

3. Thrombosed aneurysm

4. Operative bed following resection.

D. Demyelinating Disorder

1. Radiation necrosis

2. Tumefactive demyelinating lesion

3. Necrotizing leukoencephalopathy after methotrexate

Single small contrast enhancing CT lesion (SSECTL) is the commonest presentation in neuroimaging study. The commonest etiology is neurocysticereosis followed by tuberculomas.

NEUROCYSTICERCOSIS

Neurocysticercosis (NCC) is a major cause of neurological disease world-wide[28,29]. It is an important cause of epilepsy in the tropics[30] and was found to be the commonest cause of focal seizures in North Indian children[31].

Neurocysticercosis is caused by infestation of the CNS with encysted larvae of Taenia solium.

The cyst has 4 stages

1. **Vesicular Stage (Metacestode):** The parasite lives in tissues as a fluid-filled cyst with a thin semitransparent wall. The scolex lies invaginated on one side of the cyst and appears as an opaque 4-5 mm nodule. These viable cysts are generally asymptomatic. Once the cysts start degenerating, an inflammatory response is elicited and the cyst goes through the following stages.
2. **Colloidal stage:** The larva undergoes hyaline degeneration and gelatinous material appears in cyst fluid.
3. **Granular nodular stage:** The cyst contracts and the walls are replaced by focal lymphoid nodules and necrosis.
4. **Nodular calcified stage:** The granulation tissue is replaced by collagenous structures and calcification.

Most children present with partial seizures[32, 33, 34] particularly complex partial seizures[32]; about a quarter have simple partial seizures. Most seizures are of short duration, generally lasting for less than 5 minutes.

Diagnosis: Diagnosis rests mainly on neuroimaging.

CT scan: Parenchymal NCC

Vesicular cysts: It is generally appear as small round lesions with CSF density cystic fluid; the wall is isodense to the brain parenchyma. They are non-enhancing or mildly enhancing and are not surrounded by edema.

Degenerating (colloidal vesicular) cysts: It appears as small low-density lesions with ring or disc enhancement. The scolex appears as a bright high density eccentric nodule in these cysts and is pathognomonic of NCC. Perilesional edema of varying grades is seen in over half the cases. In most cases the lesions are single and <20mm in size-termed as single small enhancing computed tomographic lesion (SSECTL)[35]. Some children may have multiple lesions; disseminated NCC with numerous cysts may give the so called "starry –sky" appearance which is typical of NCC.

Calcified cysts: They are few mm in size, single or multiple and generally without any surrounding edema. However in children with active seizures, edema may at times be seen around calcified lesions.

MRI

Identification of scolex and visualization of extraparenchymal cysts is better with MRI. Live cysts are seen as round lesions either isointense or slightly hyperintense to the CSF. The scolex is seen as a nodule that is isointense or hyperintense relative to white matter. On T2 weighted images, the perilesional oedema appears bright and because of the high intensity cystic fluid, the scolex may not be seen. The scolex is better seen on proton density – weighted images. Gadolinium enhanced MRI shows ring enhancement of lesion. Calcified lesions appear hypointense on all MR imaging sequences and may at times be missed[36]. MRI is more sensitive for detecting scolex and

extraparenchymal NCC[37]. In cases where the scolex is not well seen, other sophisticated imaging techniques are therefore being researched.

Proton Magnetic Resonance Spectroscopy (MRS)

MRS has been tried for evaluation of inflammatory granulomas[38]. It has been suggested that presence of lipid indicates a tuberculoma whereas low levels of metabolites together with a poor signal/noise ratio could indicate NCC.

3D Constructive Interference In Steady State (3DCISS)

It is found to be more sensitive and specific than routine SE sequences in the diagnosis of intraventricular cysticercal cysts.-scolex[39].

DWI MRI

High (ADC) is seen in core of cysticercus cysts compared to tuberculomas and tubercular abscess[40].

TUBERCULOMA

Primary TB infection is usually pulmonary and is followed by lymphatic drainage of bacilli to regional lymph nodes. Further drainage of bacilli via the thoracic duct into the venous system occurs giving low grade or “silent” bacillemia[41,42]. Massive bacillemia is precipitated by a tuberculous focus, often a lymph node, eroding and discharging into a blood vessel. The brain is infected by this hematogenous disseminationand meningeal involvement is

secondary to rupture of a parenchymal tuberculoma into the subarachnoid space, rupture of a tuberculoma in a vessel related to the subarachnoid space or, very rarely, via contiguous spread from bone involvement by TB[43]. Most children present with partial seizures particularly complex partial seizures; about a quarter have simple partial seizures.

IMAGING

CT Scan

Focal parenchymal tuberculomas measure 5-30 mm but are occasionally larger, up to 60 mm. 15-20 % present with multiple, separate lesions although grape-like clusters of granulomas occur. Tuberculomas may occur anywhere in the parenchyma but have a tendency to be peripheral. A typical symptomatic tuberculoma has surrounding vasogenic edema and central necrosis. The increased interstitial space fluid of vasogenic edema is hypodense on CT.

MRI Scan

The granuloma is iso- to hyperdense on CT and on MR is slightly T1 hyperintense with marked T2 hypointensity. Small granulomas, up to 10 mm, will enhance diffusely following IV contrast on CT and on T1Gad images. This is consistent with the vasoformative component of the inflammatory process and the absence of (macroscopic) necrosis. Necrosis, usually central, is associated with loss of enhancement and results in ring-enhancing lesions.

Other causes of SSECTL like Neoplasms, Hemorrhagic – ischemic lesions and Demyelinating disorders are very rare findings in Neuro Imaging.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

There are many studies are available to know about seizures pattern in adult population, but studies are limited in pediatric population. Few studies about seizures pattern includes, **Camfield** *et al***., 1996b; Hauser** *et al***., 1993[(2)].** Studied the incidence childhood epilepsy. Studies stated that the incidence in the first year of life is about 120 in 1akh. Between 1 and 10 years, the incidence plateaus at 40-50 cases in children and then drops further in the teenage years to about 20 in 1 lakh.

Eriksson *et al.,* **1997[(3)]**. Studied a population based prevalence study from Finland, found that the main seizure types for each patient were focal in 43%, with complex partial and partial with secondary generalization most common. For 44%, generalized seizure were dominant, with generalized tonic-clonic seizures most common. Overall, 45% had localization related epilepsy syndromes, and 48% had generalized syndrome**.**

Hauser and Kurland., 1975[(6)]. Studied an Epidemiological study, found that primary generalized seizure accounted to be 40.5%. Of the primary generalized seizures, generalized tonic-clonic are the most common followed by absence and myoclonic seizure.

Juul-Jensen and Foldspang., 1983[(49)]. An Epidemiological study, they found that primary generalized seizure accounted for 45.8% of the seizure types.

Tapani keranen *et al.,* **2007**[45]. Studied an epidemiological survey of 1220 patients over 15 years of age. Stated 56% of patients had partial seizure. Sub classification of partial seizures revealed SPS in 7.5% of cases, CPS in 23%, and PSGS in 25.5% of the cases.

DiMauro and Moraes., 1993[50]. Observed that among the mitochondrial disorders, myoclonic epilepsy with ragged red fibers may manifest as myoclonic seizures in children adolescents.

Studies regarding seizure disorders and neuroimaging findings includes **Hirtz** *et al.,* **2001**[51]. Analyzed all patients presenting with their unexplained generalized tonic-clonic seizure, with the recognition that in patient with normal neurological examination. He observed that the chance of finding a treatable lesion in neuro imaging is quite low.**Beig** *et al.,* **2000a** [18]. Studied 613 children had symptomatic localization related epilepsy. 117 of 613 children had abnormal finding on MRI (28.3%).

Another study regarding seizures and neuroimaging findings**, Fariba Khodapanahandeh and Homayon Hadizadeh**., 2006[46]. Studied 125 children aged between 1 month – 15 years. Of which 22% patients presented with focal and 78% with generalized seizures. Out of 27 patients with Focal seizures, Eight (30%) and out of 92 with generalized seizures, only four (4%) had abnormal findings (Fisher Exact test, $P< 0.001$).

Single solitary enhancing CT lesions are the most common neuroimaging abnormality in developing countries. Studies are conducted in

some developing countries regarding tuberculosis and nurocysticercosis. that includes**, Singhi P.,** *et al* 2009[32]. Studied of 500 children with neurocysticereosis. It showed most children present with partial seizures (84-87%) particularly complex partial seizures; about a quarter had simple partial seizures.

Export Committee on Pediatric epilepsy, Indian Academy of Pediatrics[44], Stated that new onset partial or generalized convulsive seizures occurring in clusters in an otherwise normal child, single small contrast enhancing CT lesion (SSECTL) is the commonest presentation in neuroimaging study. The commonest etiology is neurocysticereosis followed by tuberculomas.

Pratibha Singhi, *et al***., 2009**. Observed that neurocysticercosis is a major cause of neurological disease worldwide[28,29] it is an important cause of epilepsy in the topics[30] and was found to be commonest cause of focal seizures in North Indian Children[31].

Berg *et al.,* **2000a[18].** The study showed only 4(0.6%) of 613 children with Epilepsy had a brain tumor in his large epidemiological study of 613 children.

Sachdev *et al***.,** 1991[55]. The commonest age group for Solitary single enhanced CT lesions between 5-8 years.**Sethi** *et al***., 1985[56] and Goulatia** *et al.,* **1987[54].** Solitary single enhancing CT lesion Sex distribution Male: Female = 5:4. **Sachdev** *et al***., 1991[55]** showed SSECTL 95% in parietal lobe, 3% in Frontal lobe, 1% in Temporal lobe..**Srinivas** *et al***., 1992[57].** Showed

SSECTL 95% seen in parietal lobe followed by 3% in occipital lobe and 2% in temporal lobe.

D.H. Jamieson *et al.,* **Springer-Verlag., 1995**[47]. Evaluated that calcifications are rarely noted in tuberculoma. Calcification is more commonly associated with cysticercus granulomas. It can be dedected in CT.**Douglas R. and Nordli., Kenneth F. Swaiman** 2006[53]. Stated as only 10% children with focal seizures have brain tumors or stroke in neuroimaging.

STUDY JUSTIFICATION

STUDY JUSTIFICATION

Seizures are the most common neurological disorder in Pediatric age group and occur in 10% of children [58]. Several times, a child may present with a condition that can mimic or be misinterpreted as a seizure. A seizure has to be differentiated from these conditions as misdiagnosis can have significant therapeutic implications. Neuro imaging used in pediatric population with new onset seizures for identification of underlying pathologies and to aid formulation of syndromic and etiological diagnosis. The entity of single small enhancing CT lesion (SSECTL) brain in children with seizures has confounded clinicians for a long time. There are contradicting views about the cause and management of these lesions both in Indian and other literature. The purpose of the study is intended to know the prevalence of various seizure types and its neurological imaging finding in our population and guide the clinicians about the prevalence state of various seizure types and various disease prevalent states in our population.

OBJECTIVES

OBJECTIVE

1. To study the various pattern of seizure disorders.
2. To study the neuroimaging findings in seizure disorders

METHODOLOGY

METHODOLOGY

MATERIALS

STUDY PLACE	:	K.A.P.V.Govt.Medical college and Annal Gandhi Memorial Govt. Hospital, Department of Pediatrics, Thiruchirappalli.
STUDY DESIGN	:	Descriptive study
STUDY PERIOD	:	Sep.2010 to Sep.2011.
STUDY POPULATION	:	All children aged between 28 days to 12 yrs who presented with seizure Satisfying the study criteria were included.
SAMPLE SIZE	:	100
INCLUSION CRITERIA	:	All children aged between 28 days to 12 yrs who got admitted with documented Convulsive episodes.
EXCLUSION CRITERIA	:	Convulsion with the history suggestive Of acute antecedent events like trauma, Drugs, toxins. Associated with fever Cerebral palsy.

METHOD

In this study, hundred children aged 28 days to 12 yrs with seizure, admitted to the Pediatric Ward of Annal Gandhi memorial government hospital, Trichy, between September 2010 to September 2011 were studied. Among the study group 53 were boys and 47 were girls.

The Study group was divided into 5 subgroups

1. Infants (28 days to 1 year)
2. Toddlerhood (2 to 3 years)
3. Preschool (3 to 6 years)
4. School age (6 to 10 years)
5. Adolescence.

We excluded neonatal seizures and seizures with fever, because these disorders are diagnostically and therapeutically different. We also excluded patients presenting with seizures following acute antecedent events like drugs, toxins and trauma. Cerebral palsy with seizure disorders also excluded from study.

After getting informed consent from both patient and parents, historical and clinical data are collected and entered in the proforma (annexure 2).

History included patients age, sex, time and place of seizures, duration of seizures, type of seizures(generalized / focal and multifocal / myoclonus, myoclonic seizures and infantile spasms), the presence of any predisposing conditions (history of fever, diarrhea and dehydration, ear discharge,

exanthematous illnesses, cough with expectoration, and any skin infections) and any antecedent events (history of drugs ingestion, trauma, and toxins). Detailed antenatal, natal and postnatal history including the history suggestive of perinatal asphyxia obtained from parents. Detailed developmental and immunization history obtained from parents. History of pork ingestion and history of contact with open case of TB were obtained.

Detailed general examination, head to foot examination to look for markers of TB infection and neurocutaneous markers were done. Vital signs were monitored including temperature and detailed neurological examination done specifically to look for focal neurologic signs, and any other abnormal findings. other systems were examined.

Neuroimaging was done after stabilization. Among the hundred children, 93 patients had CT examination, 24 patients had MRI scanning. 15 children had both examination and 7 children had direct MRI. Findings were documented in proforma.neuroimaging findings are categorized into 10 classes which includes Normal study, Ring enhancing lesions, Neuro degenerative disorders, Tumors, Cerebrovacular accident, Congenital structural defect, Calcifications, Neuro cutaneous syndrome, Metabolic disorders, and others categorized as Miscellaneous.

Statistical analyses were conducted using SPSS 17 software. The pattern of seizure distribution and correlation between seizure pattern and neuroimaging findings were analyzed.

RESULTS AND ANALYSIS

RESULTS AND ANALYSIS

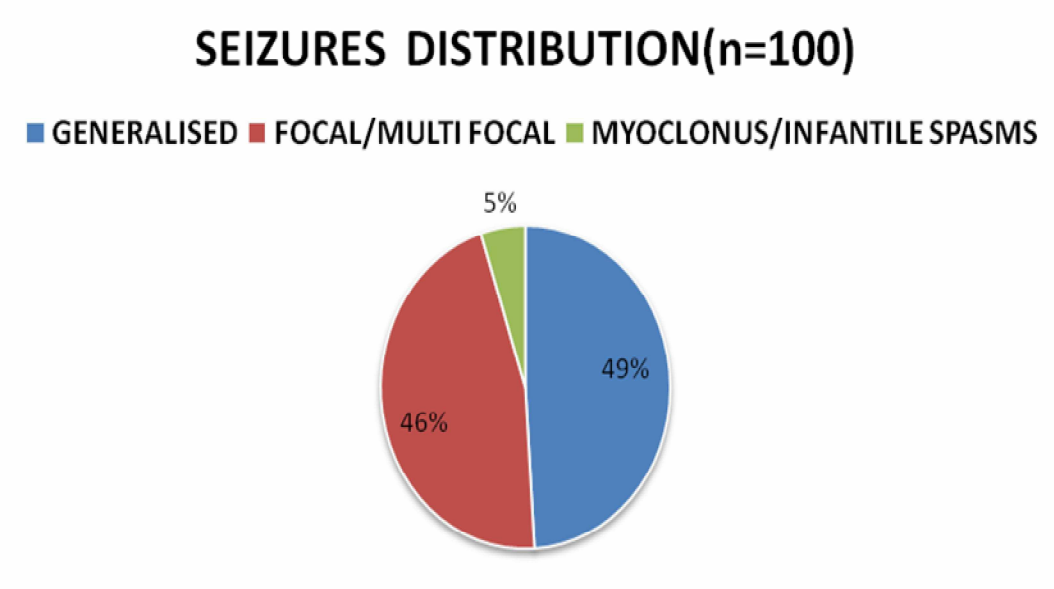
All patients were subjected to neuroimaging study, preferably MRI study. In non emergency settings, the imaging test of choice is the MRI. 93 patients had CT scan, 24 patients had MRI examination, 15 patients had both scanning, 7 patients had direct MRI scanning.4patients was shown normal findings in CT examination but MRI revealed imaging abnormalities. 2 patients had some ill defined lesions, MRI showed normal finding. Many a times MRI helped us to differentiate neurocysticercosis and tuberculomas. MRI study clearly delineated metabolic, neurodegenerative, and neurocutaneous disorders.

In our study Primary generalized seizures accounted 49 %(49/100), focal and multifocal seizures accounted for about 46 %(46/100) and myoclonic variety accounted 5%(5/100).(Fig-1)

Of the primary generalized seizures, GTCS 95 % (45/47) are the most common, followed by absence 2.5 % (1/47) and GTS 2.5 % (1/47). Of the focal and multifocal, CPS 63 % (29/46), SPS and PSGS accounted each of 17% (8/46), in myoclonic seizures 5% (5/100), myoclonic seizures accounted 4% (4/100) and infantile spasms accounted 1% (1/100).(Fig-2).

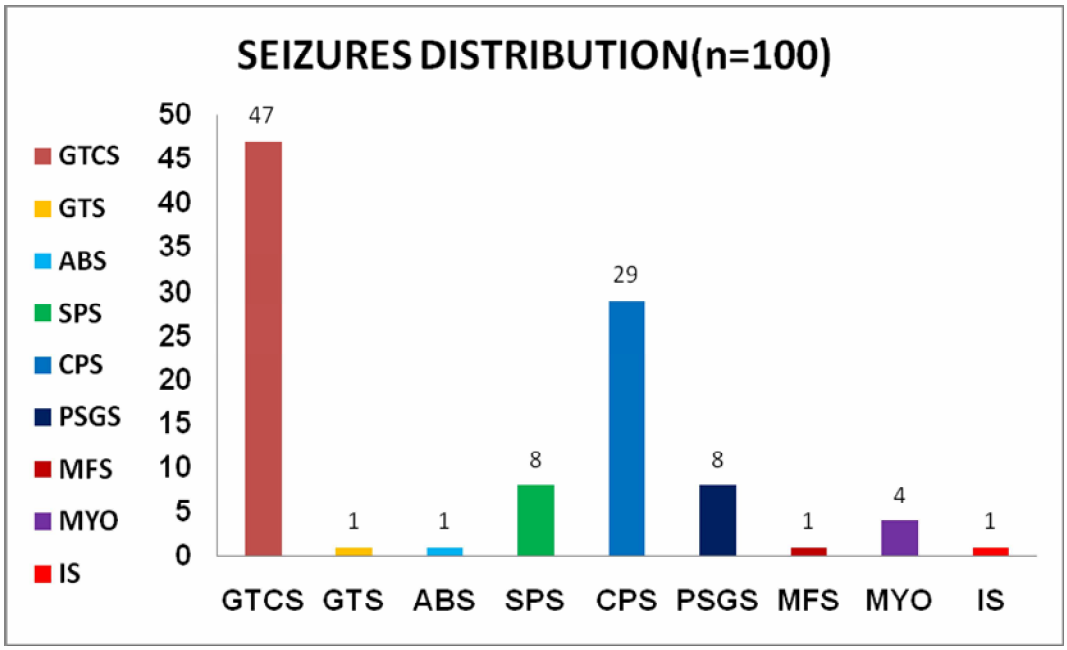
SEIZURES DISTRIBUTION (n=100)

(Fig-1)



SEIZURES DISTRIBUTION (n=100)

(Fig-2)



Boys were 53%, girls were 47%

In age distribution, infants accounted 5% (95/100) of studied population. Toddlerhood accounted 11% (11/100). Preschool children accounted 27% (27/100), school age children accounted 37% (37/100). Adolescence accounted for 20 % (20/100).(Fig-3)

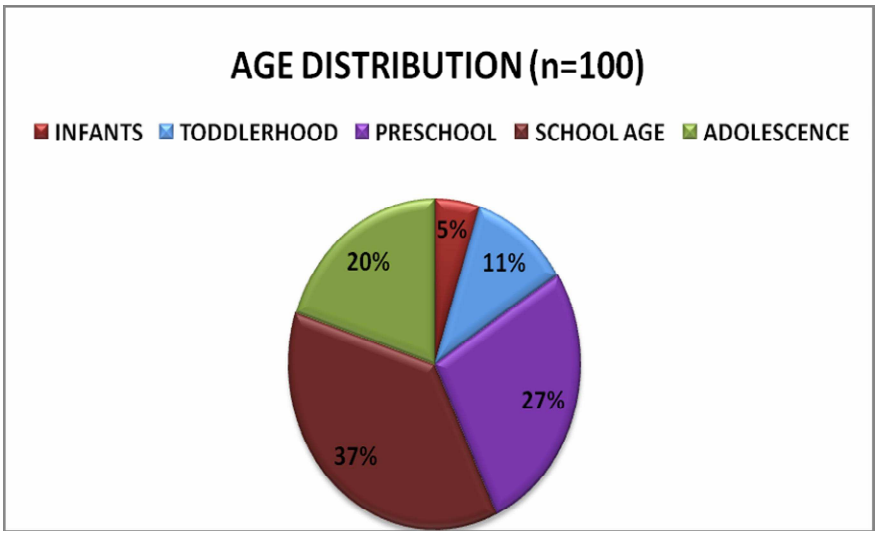
Neuroimaging abnormalities were found in 53% (25/47) of generalized seizures(Fig-5), but 97% (45/46) of focal and multifocal seizures had neuroimaging abnormalities. Myoclonic seizures have shown 60% (3/5) of neuroimaging abnormalitities.

Normal neuroimagings study was found in 29% (29/100) of patients,(Fig-5)

Ring enhancing lesions are found 35% (35/100) (Fig-6). Of the ring enhancing lesions. Tuberculomas are accounted 65% (23/35), were as Neurocysticercosis accounted for 35% (12/100)(Fig-7). Age distribution in REL shown as toddlerhood 2.9% (1/35), school age 25.9% (9/35) and adolescence 22.9% (8/35) (Table-1) (Fig-8 & Fig-9). REL are seen in boys for about 48% (17/35) and in girls 51% (18/35). REL are more common in parietal region 60% (21/35), followed by frontal region in 20% (7/35), occipital in 8.6% (3/35), and temporal regions in 8.6% (3/35) and REL are seen in multiple sites for 2.9% (1/35) (Table-2).

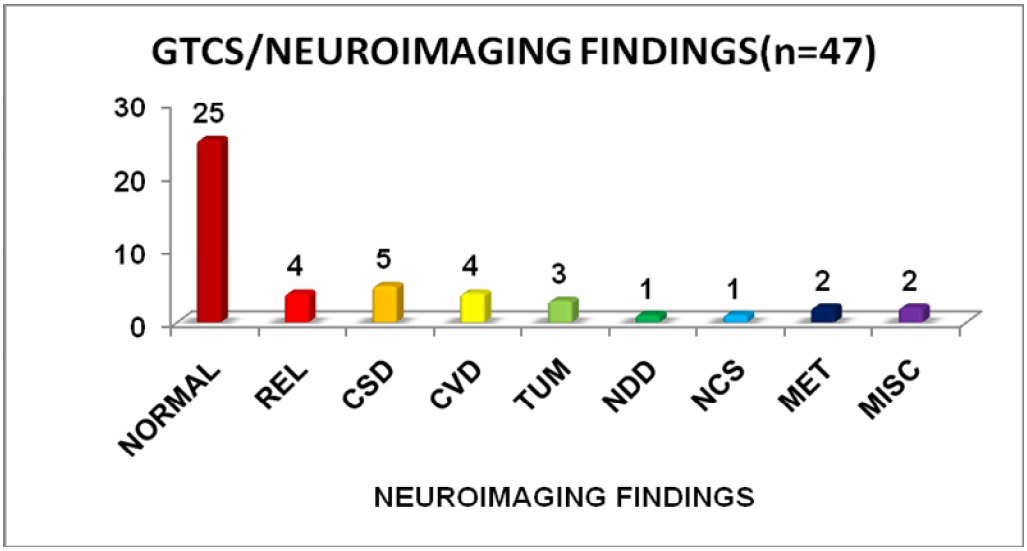
AGE DISTRIBUTION(n=100)

(Fig-1)



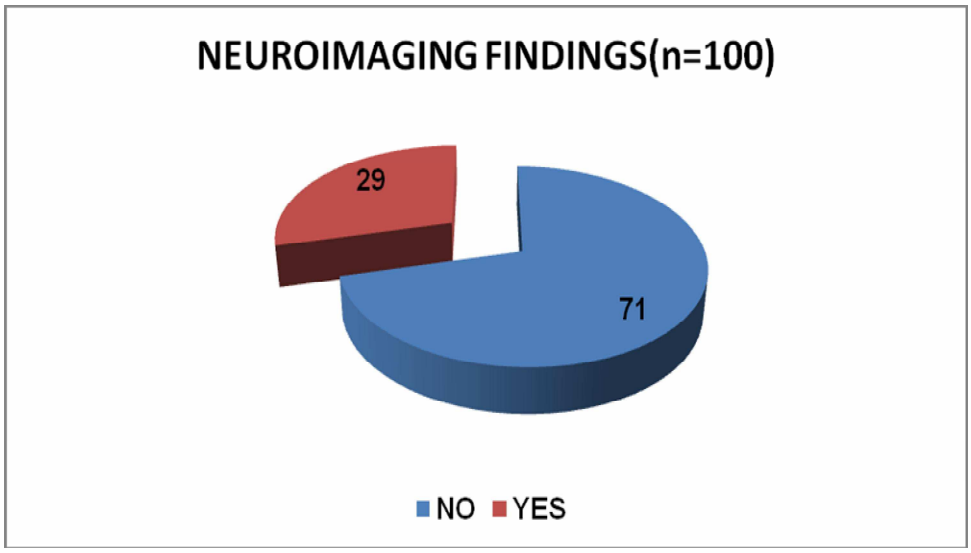
GTCS –NEUROIMAGING FINDINGS (n=47)

(Fig-4)



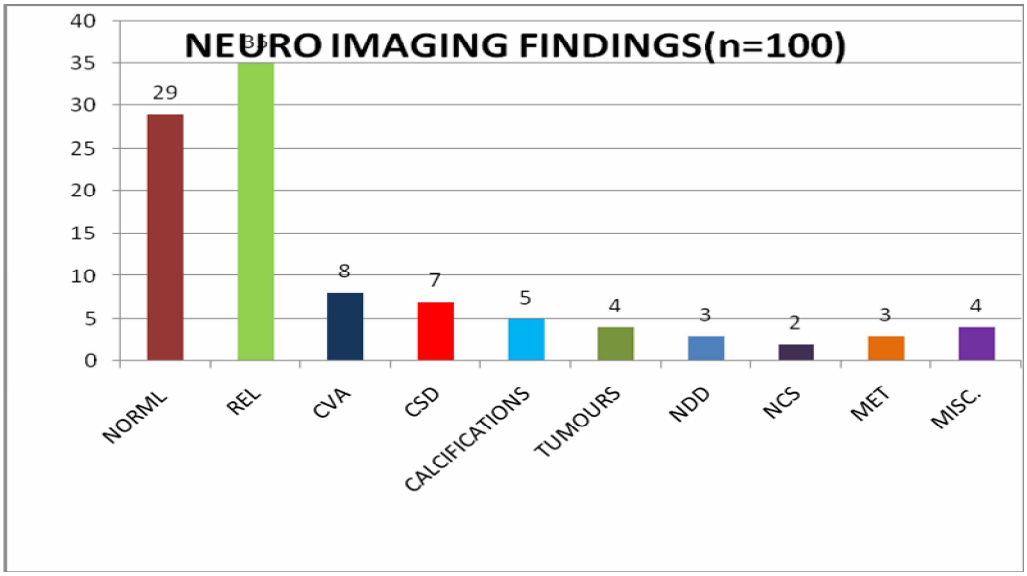
NEUROIMAGING FINDINGS(n=100)

(FIG-5)



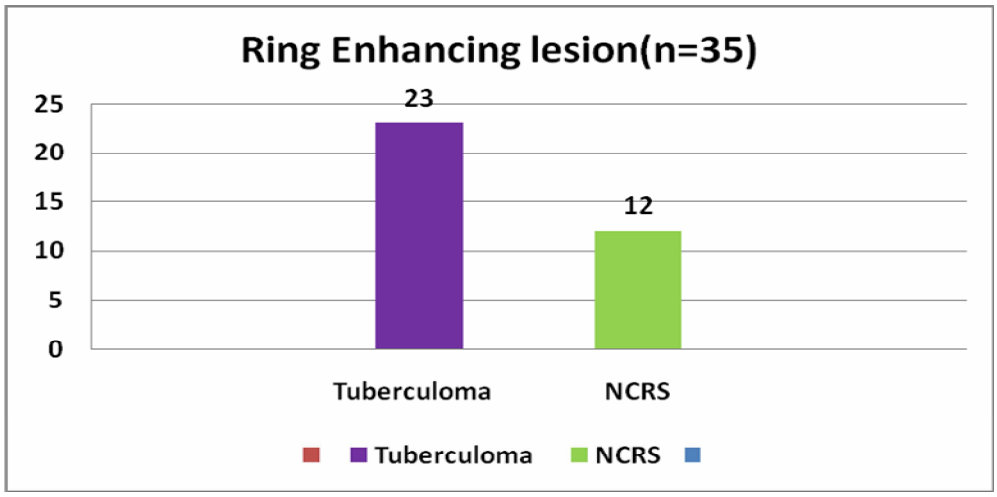
NEUROIMAGING FINDINGS(n=100)

(FIG-6)



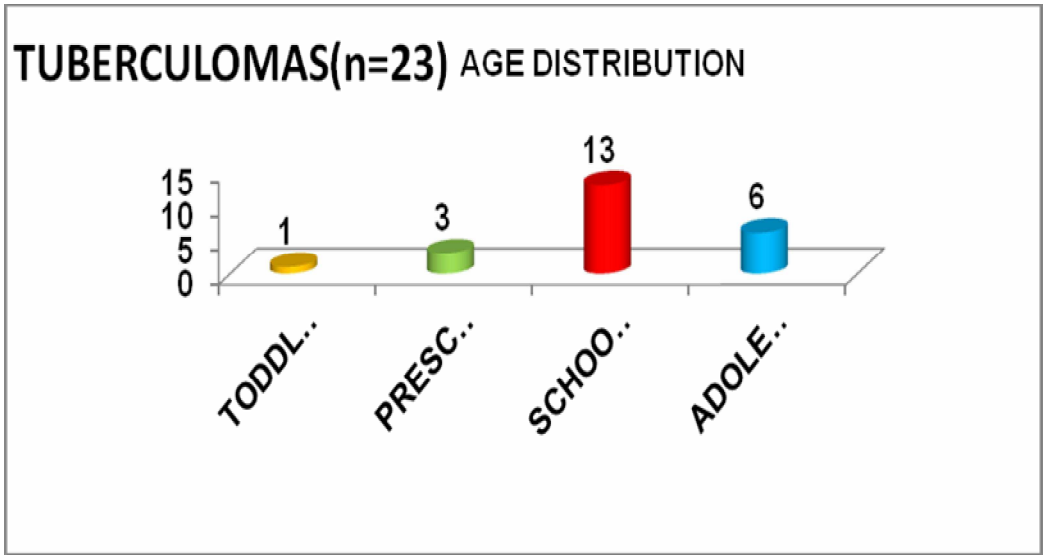
REL-DISTRIBUTION (n=35)

(Fig-7)



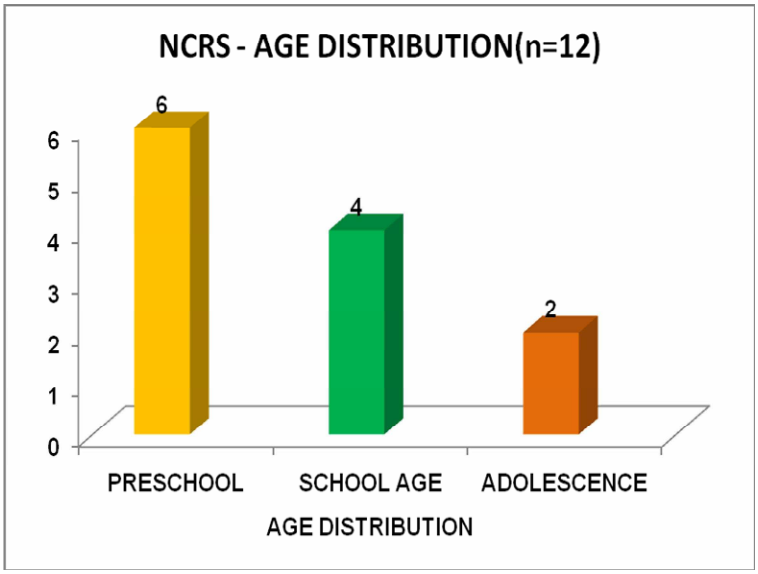
REL-TUBERCULOMA AGE DISTRIBUTION (N=23)

(Fig-8)



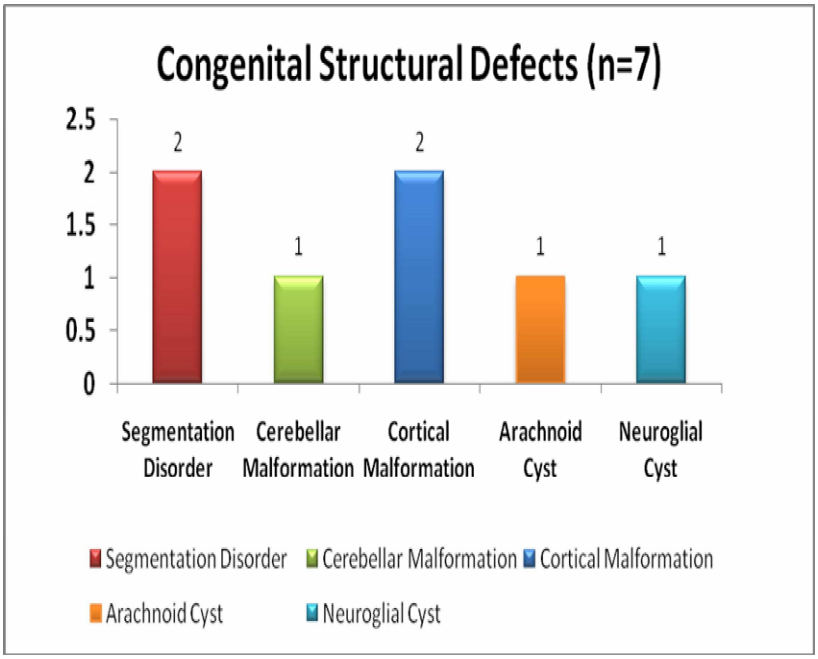
REL-NEUROCYSTICERCOSIS-AGE DISTRIBUTION(n=12)

(Fig-9)



CONGENITAL STRUCTURAL DEFECTS (n=7)

(Fig-10)



REL-AGE DISTRIBUTION(n=100)

(Table-1)

		Frequency	Percent
Valid	toddlerhood	1	2.9
	Preschool	9	25.7
	Schoolage	17	48.6
	Adolescenc	8	22.9
	Total	35	100.0

REL- REGIONAL DISTRIBUTION (n=29)

(Table-2)

	Frequency	Percent
Frontal	2	6.9
Temporal	2	6.9
Parietal	18	62.1
Occipital	2	6.9
Total	29	100.0

Congenital structural defects constituted 7% (7/100) of imaging findings (Fig-6). Of which Disorder of segmentation accounted 2% (2/100) Schizencephaly 1% (1/100) and Carpus callosal agenesis 1% (1/100), Cerebellar malformations (Dandy-walker malformation) accounted 1% (1/100), Malformation of cortical development 2% (2/100) Lissencephaly 1% (1/100) and Heterotopia 1% (1/100), Arachnoid cyst 1% (1/100) and Neuroglial cyst 1% (1/100) of neuroimaging findings(Fig-10).

Cerebrovascuar accident 8 % (8/100) and Tumors 4% (4/100) (PNET 1% (1/100), Craniopharyngioma 1% (1/100), Basal ganglia mass 1% (1/100), Astrocytoma 1% (1/100)) accounted for 12% (12/100) of neuroimaging

findings (Fig-6). Calcifications accounted for about 5% (5/100) of findings in neuroimaging.(Fig-6)

Neurodegerative disorders constituted for about 3% (3/100) of neuroimaging findings Fig-6 Adrenoleukodystrophy-1% (1/100), Tay Sach's disease (neuroimaging abnormality correlated with history and clinical examination) -1% (1/100) and Metachromatic leukodystrophy -1% (1/100)).

Neurocutaneous syndromes accounted for 2% (2/100) of neuroimaging findings (Fig-6). Of the neurocutaneous disorders Tuberous sclerosis (tubers was seen in ependymal surfaces of ventricles in contrast CT Brain) was seen in 1% (1/100) of neuroimaging findings and leptomeningeal angioma in occipital region (Sturge-weber syndrome) was the imaging findings in 1% (1/100).

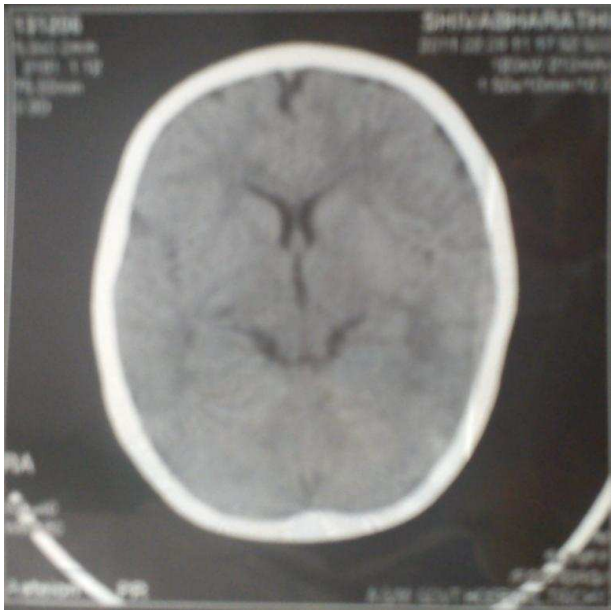
Diagnosis of Metaboic disorders made with metabolic workup along with MRI imaging of brain. Phenylketonuria (urine metabolic screening for metabolic screening-ferric chloride test was positive for phenylketonuria) accounted 1% (1/100) of imaging findings. Wilson's disease (laboratory report shown decreased serum Copper levels) constituted 1% (1/100) of imaging's. Leigh's syndrome (bilateral Symmetrical hyper intensities were seen in both basal ganglia region). MRS was planned to see for lactate peaks. Patient expired on third day due to Refractory seizures.

Other findings were included as Miscellaneous findings 4% (4/100), (Fig-6) which includes Mesial temporal sclerosis 1% (1/100), Posterior Reversible Encephalopathy Syndrome Following hypertensive encephalopathy 1% (1/100), Post viral Encephalomyelitis 1% (1/100) and Postictal edema 1% (1/100).

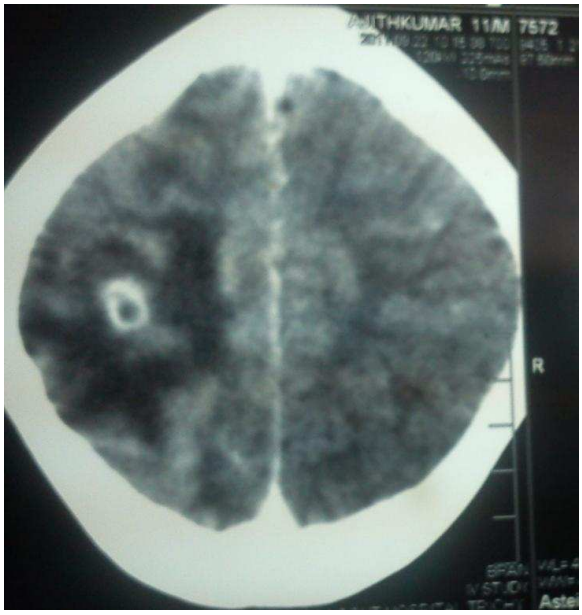
NEURO IMAGINGS

NEURO IMAGINGS

BRAIN NORMAL STUDY IN COMPUTED TOMOGRAPHY



TUBERCULOMA BRAIN IN COMPUTED TOMORAPHY



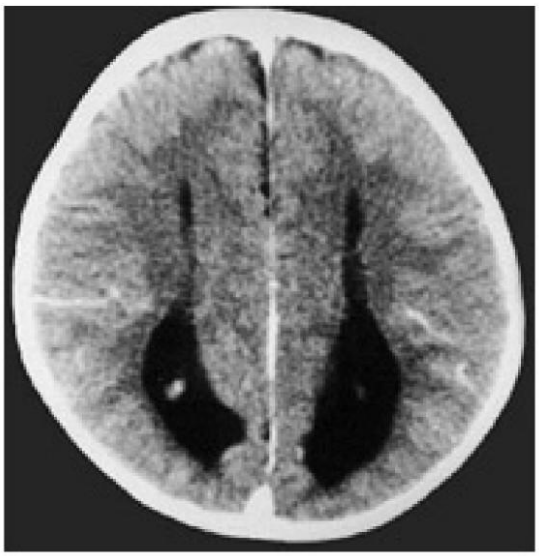
PARANCHYMAL NEUROCYSTICERCOSIS IN COMPUTED TOMOGRAPHY

OPEN LIP SCHIZENCEPHALY IN MRI

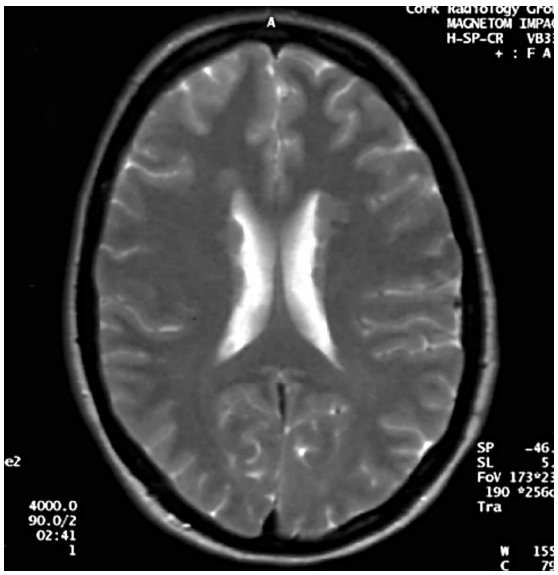
DANDY – WALKER MALFORMATION IN MRI

LISSENCEPHALY IN COMPUTED TOMOGRAPHY

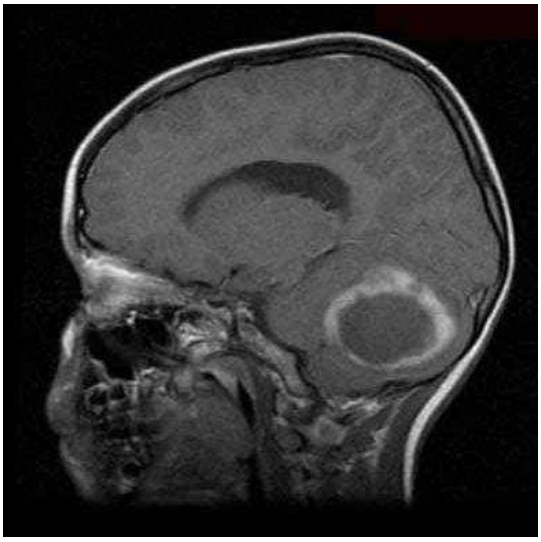
CARPUS CALLOSAL AGENESIS IN COMPUTED TOMOGRAPHY



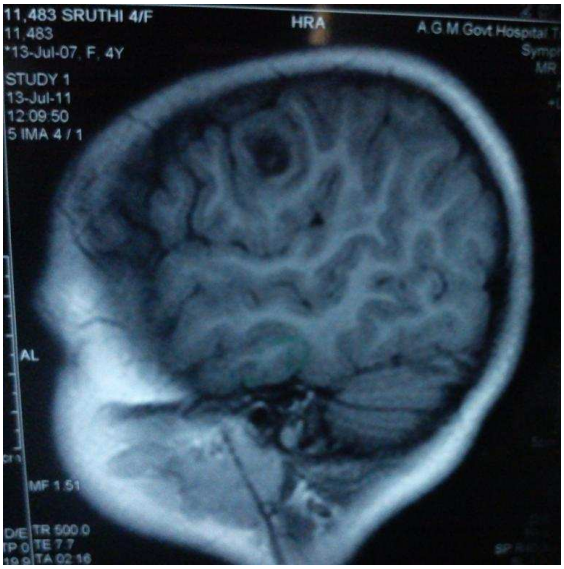
HETEROTOPIA IN MRI



ARACHNOID CYST IN MRI



NEUROGLIAL CYST IN MRI

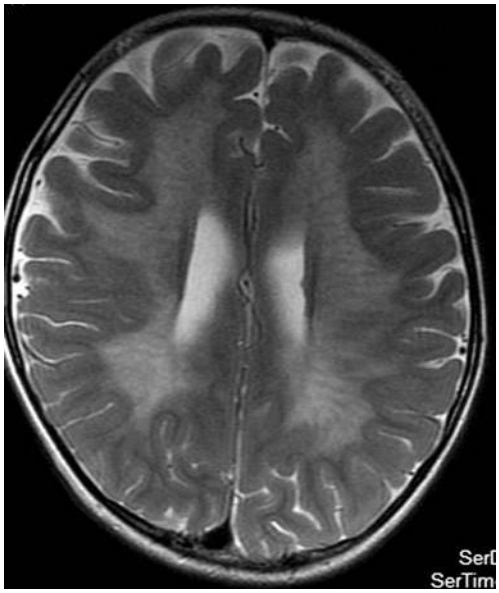


LEFT MCA INFARCT IN COMPUTED TOMOGRAPHY

PNET (TUMOR) IN MRI

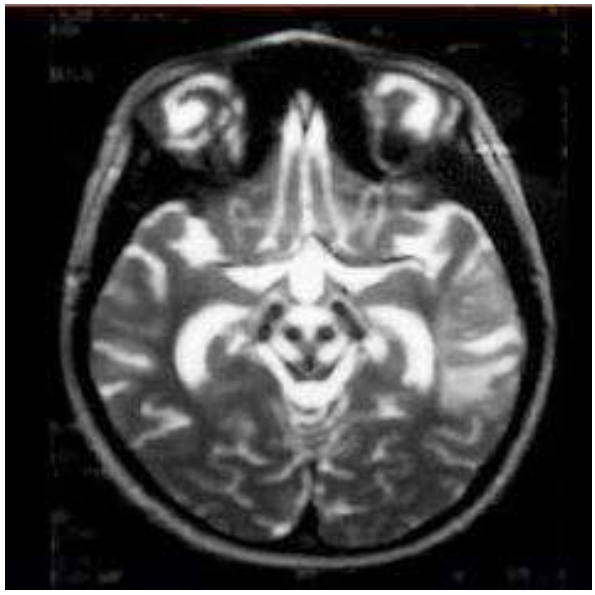
CALCIFICATION IN COMPUTED TOMOGRAPHY

METACHROMATIC LEUKODYSTROPHY IN MRI



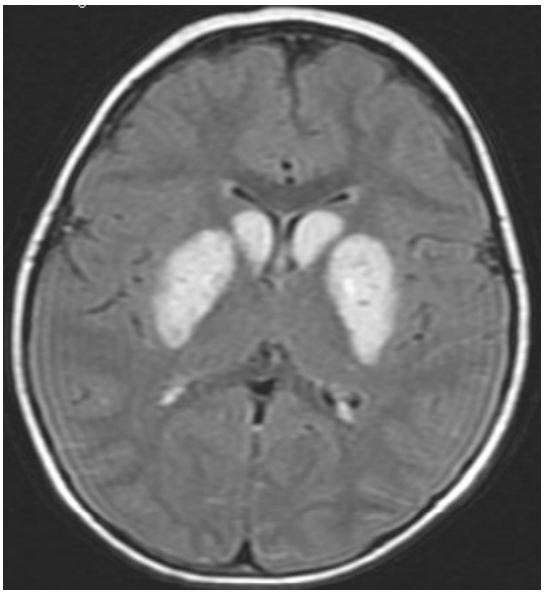
TUBEROUS SCLEROSIS IN COMPUTED TOMOGRAPHY

WILSON'S DISEASE (GIANT PANDA'S SIGN) IN MRI

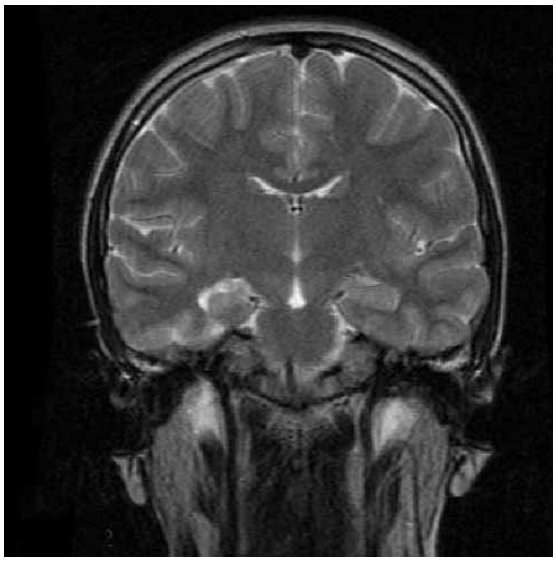


LEPTOMENINGEAL ANGIOMA (SWS) IN COMPUTED TOMOGRAPHY

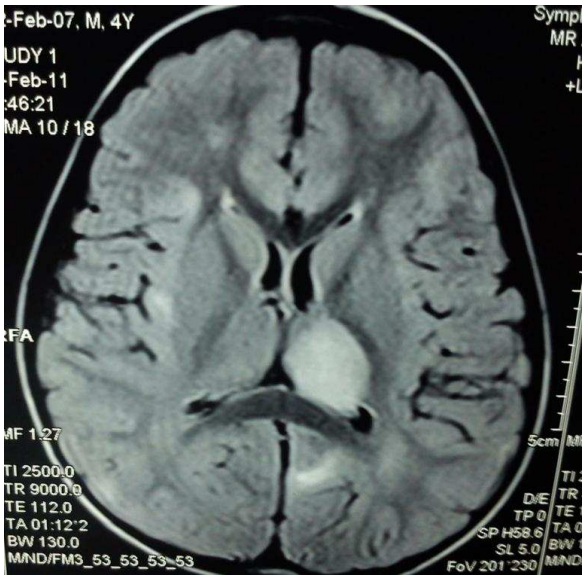
LEIGH'S SYNDROME IN MRI



MESIAL TEMPORAL SCLEROSIS IN MRI



POST VIRAL ENCEPHALO MYELITIS IN MRI



DISCUSSION

DISCUSSION

1. In our study, seizures are more common in school age children (37/100) and then drops in teenage years, were as previous study (**Camfield** *et al*,)[2]. Stated that the incidence is high in Infancy and between 1-10 years of age, the Incidence plateaus and then drops in teenage group. Seizures are more common in school age children beyond infancy excluding fever related epilepsies.
2. In our study, the most common seizures type is generalized seizures accounted for 49% (49/100) followed by focal and multifocal 46% (46/100) and myoclonic seizures 5% (5/100). Previous study stated that 48% had generalized epilepsy syndromes and 45% had localization related epilepsy (**Eriksson** *et al)*[3]. Both studies are comparable to each other. Generalized seizures are more common followed by localization related seizures.
3. In our study, of generalized seizures generalized tonic-clonic seizures accounted for 95% (47/49) followed by absence 2% (1/47). Of focal and multifocal seizures, complex partial seizures accounted for 63% (29/46) of seizure type followed by partial seizures with generalized seizures 17% (8/46). These data's are comparable to previous studies (**Hauser** and **Kurland**)[6] (**Tapani Keranen, Matti Sillanpaa**)[45]. Of the primary generalized seizures, generalized tonic clonic are the most common, followed by absence. Of the focal and multi focal seizures, complex partial

seizures are more common followed by partial seizure with generalized secondary.

4. In our study, Normal neuroimaging accounted 29% (29/100) and neuroimaging abnormalities were found in 71% (71/100). Previous studies **(Fariba Khodapanahandeh and Homayon Hadizadeh**), 2006[46], stated that neuroimaging abnormalities seen in small population of patients. In our study, we excluded the most common causes of seizures like acute CNS infection, trauma, toxin and drug induced seizures. We also excluded febrile convulsions and seizures caused by cerebral palsy. It may be the cause for these differences.
5. In our study, Neuro imaging abnormalities were seen more with localization related epilepsies 97% (45/46) than generalized seizures. In generalized seizures Neuro imaging abnormalities were seen in 46% (22/47). Normal imaging was shown in 54% (25/47) of generalized seizures. This study is comparable to previous studies done by (**Hirtz** *et al*,)[51] (**Fariba khodapanahandeh** and **Homayon Hadizadeh**)[46]. Neuro imaging abnormalities are more common with localization related epilepsy.
6. In our study, the most common Neuroimaging findings are Ring enhancing lesions 35% (35/100), which is comparable to study done previously in certain developing country like India (**Export committee on pediatric epilepsy, Indian academy of pediatrics**)[44]. Single small enhancing CT Lesion brain is the most common neuro imaging abnormality in developing countries.

7. Our study stated that Tuberculoma brain is the most common cause for Ring enhancing lesion in children which accounted for 65% (23/35) of ring enhancing lesions followed by neurocysticercosis which is accounted for 35% (12/35) of such lesions. **Nelson text book of Pediatrics** [(52)] stated as Tuberculomas are account for up to 40% of brain tumor in some areas of world. Tuberculomas are the most common neuro imaging findings in some developing countries.
8. Both Tuberculomas and neurocysticercosis are seen mostly in parietal region 60% (21/35), which is comparable to previous studies conducted in India (**Sachdev** *et al*.,) [(55)] (**Srinivas** *et al*)[(57)] SSECTL brain are more common in parietal region.
9. In our study, Ring enhancing lesions were common among preschool and school age children, Tuberculomas were common among school age children 56% (13/23), were as Neurocysticercosis are common among preschool children 50% (6/12),Previous study stated that SSECT lesion are common between 5-8 years (**Sachdev** *et al*.,)[(55).]. Our study is comparable to previous study conducted in india. Ring enhancing lesions are common among Pre school and School age children.
10. Tumors and Cerebro Vascular Disease accounted for about 12% (12/100) of studied population in our study which is comparable to previous study (**Douglas R** and **Nordli**)[(53)]. Tumors and strokes constituted 10% of neuroimaging findings among the seizure population.

11. In our study, Myoclonic seizures are associated with neuro degenerative disorders and metabolic disorders. Previous studies stated that myoclonic seizures are associated with mitochontrial, storage and progressive disorders (**DiMauro** and **Moraes**)[50]. Hence myoclonic seizures need evaluation for neurodegenerative and metabolic disorders.
12. Other neuroimaging findings include Congenital structural defects 7% (7/100), Calcification 5% (5/100), Neuro degenerative disorders 3% (3/100), Metabolic disorders 3% (3/100), Miscellaneous conditions like ADEM, MTS, Post ictal edema, Reversible posterior encephalopathy syndrome. No much studies are available to compare these disorders.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSIONS

- Generalised seizures are the most common seizure and generalized tonic-clonic seizures are the most common seizure in subclassification.
- Generalized seizures are mostly associated with normal neuroimaging study
- Focal and multifocal seizures are mostly associated with neuroimaging abnormalities.
- Children and adolescents presenting with myoclonic epilepsies, need an evaluation for mitochondrial, storage, and other progressive disorders like degenerative disorders.
- Single small solitary enhancing lesion brain are the most Common neuroimaging findings in children in our population.
- Among SSECTL brain, Tuberculomas are most common followed by Neurocysticercosis in our population.

RECOMMENDATIONS

RECOMMENTATIONS

- All children presenting with seizure require neuroimaging study and electroencephalography with other specific investigations as needed.
- ‘Tuberculomas are most common neuroimaging finding in our population. Hence strategies to be implemented to prevent tuberculous infection among children.

ANNEXURES

MASTER SHEET (Annexure-1)

S. No	AGE	SEX	TOS	NS	REL	REL-S	REL-R	NDD	TUM	CVA	CSD	CSD-C	CAL	NCS	MET	MISC
1	4	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
2	4	2	5	-	1	1	3	-	-	-	-	-	-	-	-	-
3	5	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
4	4	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-
5	3	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
6	4	1	8	-	-	-	-	1	-	-	-	-	-	-	-	-
7	5	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-
8	4	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
9	5	2	5	-	1	1	3	-	-	-	-	-	-	-	-	-
10	3	1	5	-	-	-	-	-	-	-	1	1	-	-	-	-
11	3	1	4	-	-	-	-	-	-	1	-	-	-	-	-	-
12	3	1	5	-	-	-	-	-	-	-	-	-	-	-	-	1
13	4	2	6	-	-	-	-	-	-	-	-	-	-	-	-	2
14	4	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
15	5	2	4	-	-	-	-	-	-	-	-	-	1	-	-	-
16	4	1	5	-	1	2	3	-	-	-	-	-	-	-	-	-
17	3	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
18	4	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
19	3	2	6	-	2	1	4	-	-	-	-	-	-	-	-	-
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23	3	2	4	-	2	2	3	-	-	-	-	-	-	-	-	-

24	3	2	5	-	1	2	3	-	-	-	-	-	-	-	-	-
25	3	2	1	-	-	-	-	-	-	-	5	-	-	-	-	-
26	4	2	1	-	-	-	-	-	1	-	-	-	-	-	-	-
27	5	2	5	-	2	2	3	-	-	-	-	-	-	-	-	-
28	3	1	1	-	1	1	1	-	-	-	-	-	-	-	-	-
29	4	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
30	5	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
31	2	1	1	-	-	-	-	2	-	-	-	-	-	-	-	-
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83	3	1	5	-	2	1	3	-	-	-	-	-	-	-	-	-
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89	4	1	4	-	1	1	2	-	-	-	-	-	-	-	-	-
90	1	2	1	-	-	-	-	-	-	1	-	-	-	-	-	-
91	5	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
92	4	2	5	-	1	1	3	-	-	-	-	-	-	-	-	-
93	3	1	4	-	-	-	-	-	-	-	-	-	1	-	-	-
94	2	1	1	-	1	2	1	-	-	-	-	-	-	-	-	-
95	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	4
96	3	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
97	1	1	5	-	-	-	-	-	-	1	-	-	-	-	-	-
98	4	2	5	-	2	1	4	-	-	-	-	-	-	-	-	-
99	5	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
100	3	1	5	-	2	1	4	-	-	-	-	-	-	-	-	-

KEY TO MASTER CHART

S.No - Serial Number

AGE - 1-Infants

2-Toddlerhood (2-3 YR)

3-Preschool (3-6 YR)

4-School age (6-10 YR)

5-Early adolescence (11-12 YR)

SEX - 1-Boys; 2-Girls

TOS - Type of seizures

1-Generalised tonic clonic seizure

2-Generalised tonic seizure

3-Absence seizure

4-Simple partial seizure

5-Complex partial Seizure

6-Partial with secondary generalization

7-Multifocal Seizure

8-Myoclonic seizure

9-Infantile spasms

NS - Normal study

1-Normal study

REL - Ring enhancing lesions

1-Tuberculoma

2-Neurocysticercosis

REL-S - Ring enhancing lesions-side

1-Left

2-Right

3-Multiple

REL-R - Ring enhancing lesion-region

1-Frontal

2-Temporal

3-Parietal

4-Occipital

NDD - Neuro degenerative disorders

1-Adrenoleukodystrophy

2-Metachromaticleukodystrophy

3-Tay Sach's disease

TUM - Tumors

CVA - Cerebrovacular accident

CSD - Congenital structural defect

1-Disorder of segmentation

2-Cerebellar malformation

3-Malformaton of cortical development

4-Arachnoid cyst

5-Neuroglial cyst

CSD-C - Congenital structural defect-Classification

1.1-Schizncephaly

1.2-Carpal callosal agenesis

2.1-Dandy-Walker Malformation

3.1-Lissencephaly

3.2-Heterotopia

CAL - Calcifications

NCS - Neuro cutaneous syndrome

1-Tuberous sclerosis

2-Sturge Weber Syndrome

MET - Metabolic disorders

1-Phenylketonuria

2-Wilson’s disease

3-Leigh’s syndrome

MISC - Miscellaneous

1-Mesial temporal sclerosis

2-Posterior reversible encephalopathy syndrome

3-Post viral encephalomyelitis

4-Postictal edema

PROFORMA (Annexure-2)

Name:

Age/Sex: Date of Admission:

IP No/OP No: Date of Discharge:

Informant:

Consanguinity:

Address:

CONVULSIONS

Date/Time:

Place:

No of episodes:

Duration:

Type of seizures

Generalized

Focal and Multifocal

Myoclonus,Myoclonic seizures, And infantile spasms

Nature of seizures

Tonic-Clonic/Clonic /Tonic/Atonic/Absence (typical/atypical)

Simple partial/Complex partial/Partial with secondary generalization

Myoclonic

Associated factors

Prodromes/Aura/Autonomic Phenomena/ALOC/Bladder and bowel Incontinence/Frothing from mouth/Version/Automatisms

Seizures activation

Postictal deficit

Mode of arrest

Spontaneous/with medications

H/o Fever (Infections)

H/o Drugs/Trauma/Toxins

H/o Gross developmental delay

Previous similar episodes of seizure

Antenatal/Birth/Neonatal History

Family history/Contact History

EXAMINATION

General examination

Head to foot examination

Examination of Central Nervous System and Peripheral Nervous System

NEURO IMAGINGS

Cranial Ultra Sonograrhy

Computed Tomography

Magnetic Resonance Imaging

Other Imagings

Magnetic Resonance Spectroscopy, Diffusion-Imaging, Perfusion Mri, Susceptibily -Weighted Imaging, Functional Mri, Magnetic Source Imaging.

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